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Report of Test Results AASHO Cooperative Check Test Program

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16. ABSTRACT

Gentlemen:

Submitted herewith are the results of the 1951 A.A.S.H.O. Cooperative Check Test Program. Twelve western state laboratories participated in this program covering tests on one sample of soil, one sample of SC-3 asphaltic road material, one sample of 85-100 penetration asphalt cement, and seven samples of Portland Cement.

The following is quoted from the letter of December 6, 1950, signed by T.E. Stanton, transmitting the samples:

"Tests should be made in the routine manner in which you handle samples from your construction and maintenance projects. Deviations from the standard A.A.S.H.O. or A.S.T.M. procedures should be noted when tabulating the results.

Each test should be performed three times, if time permits. Test results should then be reported in tabular form, showing the results of each test performed and the average of the three tests."

The results received and tabulated in this report are an average of from one to nine individual test results. It is assumed that where only one test result was received, that result was an average of three or more individual tests.

As far as could be ascertained, all results reported herein are in strict accordance with the standard procedures as indicated throughout this report. Several states reported results from modifications of the standard, but these results have been omitted from this report.

F.N. Hveem

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STATE OF CALIFORNIA

DIVISION OF HIGHWAYS

MATERIALS AND RESEARCH DEPARTMENT

REPORT OF TEST RESULTS

A. A. S. H. O.
COOPERATIVE CHECK TEST PROGRAM
1951

WESTERN GROUP

52-02

State of California
Department of Public Works
Division of Highways
MATERIALS AND RESEARCH DEPARTMENT
3435 Serra Way
Sacramento, California

April 15, 1952

Gentlemen:

Submitted herewith are the results of the 1951 A.A.S.H.O. Cooperative Check Test Program. Twelve western state laboratories participated in this program covering tests on one sample of soil, one sample of SC-3 asphaltic road material, one sample of 85-100 penetration asphalt cement, and seven samples of Portland Cement.

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As far as could be ascertained, all results reported herein are in strict accordance with the standard procedures as indicated throughout this report. Several states reported results from modifications of the standard, but these results have been omitted from this report.

In tabulating the test results, it was noted that in several instances a state's average was considerably out of line when compared to the averages of other states. In order to correct this discrepancy, the Pierce-Chauvenet Criterion of Rejection was used

to reject those averages which were statistically incompatible with the general range of results from other states. Proper notation of those results rejected are included in the tabulation.

Attention is called to the tabulation values listing the percentage variation shown for each test result. It is obvious that the percentage of variation when applied to a value of only one or two significant figures does not have the same implication as when the result represents three or four significant figures.

Since the primary purpose of this program was to determine what variation may exist in certain test results, a number was assigned to each state participating in order to keep its identity anonymous. For purposes of comparing results, number _____ was assigned your state for this report.

For convenience, this report has been divided into three separate divisions as follows:

I. Soil series covering the plasticity index and mechanical analysis of soil sample 50-4162A.

II. Asphalt series covering the tests on SC-3 asphaltic road material and 85-100 penetration road asphalt.

III. Portland cement series covering the chemical and physical tests performed on seven cement samples.

Very truly yours,

F. N. HVEEM
Materials and Research Engineer

FNH:ibl

TABLE OF CONTENTS

PART I - SOIL

Cooperative check tests on identical soil samples were made by twelve western state laboratories. The tests included in this series were as follows:

I Liquid Limit Determination (AASHO T 89-49)
II Plastic Limit Determination (AASHO T 90-49)
III Plasticity Index Determination (AASHO T 91-49)
IV Mechanical Analysis (AASHO T 27-46)

A tabulation of each state's results is shown in Table A.

The Liquid Limit Test results reported by the twelve states ranged from 19.9 to 26.0 with an average of 22.4. For eleven states, the reported results were within 3 percentage points of the average, seven were within 2 percentage points and three were within 1 point.

The Plastic Limit Test results reported by the twelve states ranged from 14.0 to 18.5 with an average of 16.1. Ten of the twelve states were within 2 percentage points of the average and seven were within 1 point.

Plasticity Indices, calculated from the above two tests, ranged from 1.4 to 10.0 with an average of 6.3. Plasticity Indices reported by eight of the twelve states were within 3 points of the average value, seven were within 2 points and three were within 1 point. Based on the generally accepted maximum plasticity index of 6 for base material, eight of the twelve states would have rejected this material; the other four states would have considered it acceptable.

Six sieves were used in the mechanical analysis of this soil, i.e., Nos. 8, 16, 30, 50, 100, and 200 sieves. Ten states reported a complete analysis and one state reported results on two of the above sieves. With the exception of one state's results on the Nos. 100 and 200 sieves, the average deviations from the average were as follows:

# 8	0.86
# 16	0.95
# 30	1.69
# 50	1.80
#100	0.74
#200	0.77

On an average of all sieves used in the calculations, all but one state were within 2 per cent, and six states were within 1 per cent of the average. Results of this test are shown in Chart II.

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COOPERATIVE CHECK TEST PROGRAM - 1951
PHYSICAL TESTS ON SOIL SAMPLE NO. 50-4162A

Table A

Laboratory	Liquid Limit		Plastic Limit		Plasticity Index		No. 8 Sieve		No. 16 Sieve		No. 30 Sieve		No. 50 Sieve		No. 100 Sieve		No. 200 Sieve	
	Average	% Var.	Average	% Var.	Average	% Var.	Average	% Var.	Average	% Var.	Average	% Var.	Average	% Var.	Average	% Var.	Average	% Var.
1	25.0	+11.5	15.0	- 7.1	10.0	+58.5	91.2	-0.6	82.5	-1.1	66.9	-0.7	46.7	-1.4	35.8	+1.8	30.7	+3.4
2	23.4	+ 4.3	16.8	+ 4.1	6.6	+ 5.6	91.0	+0.8	83.0	+0.5	67.0	-0.6	46.0	-2.8	35.0	-0.5	30.0	-1.0
3	24.0	+ 7.0	16.8	+ 4.1	7.2	+14.1	92.0	-0.3	84.0	-0.7	67.0	-0.6	47.0	-0.7	34.0	-3.3	29.0	+2.3
4	20.1	-10.4	16.5	+ 2.2	3.7	-41.4	91.0	-0.8	82.0	-1.7	65.0	-3.6	44.0	-7.1	34.0	-3.3	29.0	-2.3
5	19.9	-11.3	18.5	+14.6	1.4	-77.8												
6	20.0	-10.8	17.4	+ 7.8	2.7	-57.2	91.7	-0.1	84.0	+0.7	70.0	+3.9	47.0	-0.7	35.0	-0.5	29.7	+0.0
7	21.9	- 2.4	14.8	- 8.3	7.1	+12.5			83.3	-0.1							30.6	+3.1
8	21.0	- 6.4	14.0	-13.3	7.0	+10.9	93.4	+1.8	85.2	+2.1	70.9	+5.2	51.0	+7.7	40.2*		34.8*	
9	26.0	+15.9	16.0	- 0.9	10.0	+58.5	93.0	+1.3	84.0	+0.7	65.0	-3.6	52.0	+9.8	36.0	+2.4	30.0	+1.0
10	23.2	+ 3.4	15.8	- 2.1	7.4	+17.3	93.0	+1.3	85.0	+1.9	69.0	+2.4	48.0	+1.4	37.0	+5.2	31.0	+4.4
11	24.0	+ 7.0	16.0	- 0.9	8.0	+26.8	90.0	-1.9	81.0	-2.9	65.0	-3.6	45.0	-4.9	35.0	-0.5	28.0	-5.7
12	20.7	- 7.7	16.1	- 0.2	4.6	-27.1	91.4	-0.4	83.5	+0.1	68.1	+1.0	46.7	-1.4	34.6	-1.6	28.9	-2.7
Average	22.43	8.2	16.14	5.5	6.31	34.0	91.77	0.9	83.41	1.1	67.39	2.5	47.34	3.8	35.16	2.1	29.69	2.6
Maximum	26.0	15.9	18.5	14.6	10.0	77.8	93.4	1.9	85.2	2.9	70.9	5.2	52.0	9.8	37.0	5.2	31.0	5.7
Minimum	19.9	2.4	14.0	0.2	1.4	5.6	90.0	0.1	81.0	0.1	64.7	0.6	44.0	0.7	34.0	0.5	28.0	0.0

*Not used in computing averages

CHART I

LIQUID LIMIT – PLASTIC LIMIT – PLASTICITY INDEX

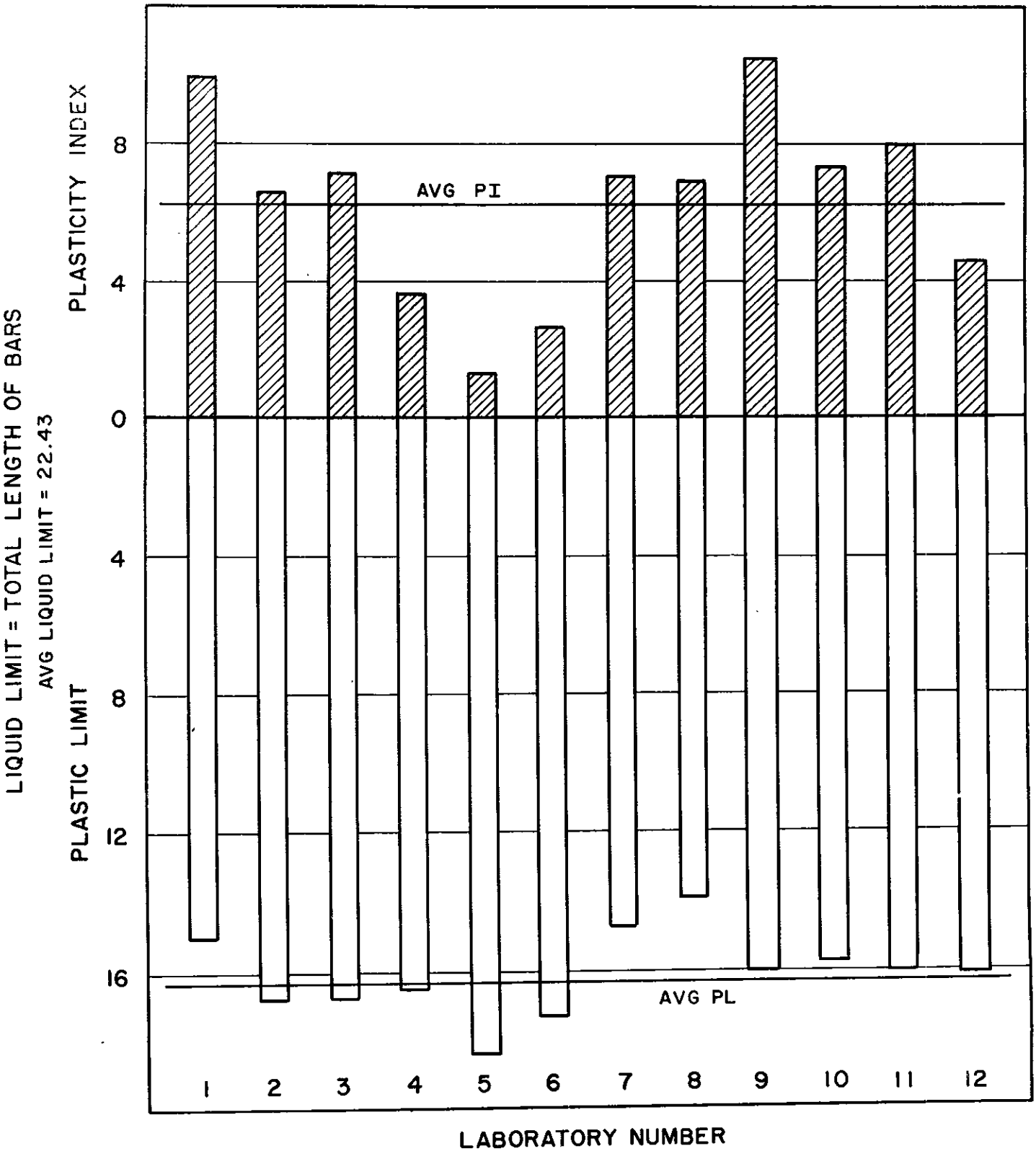
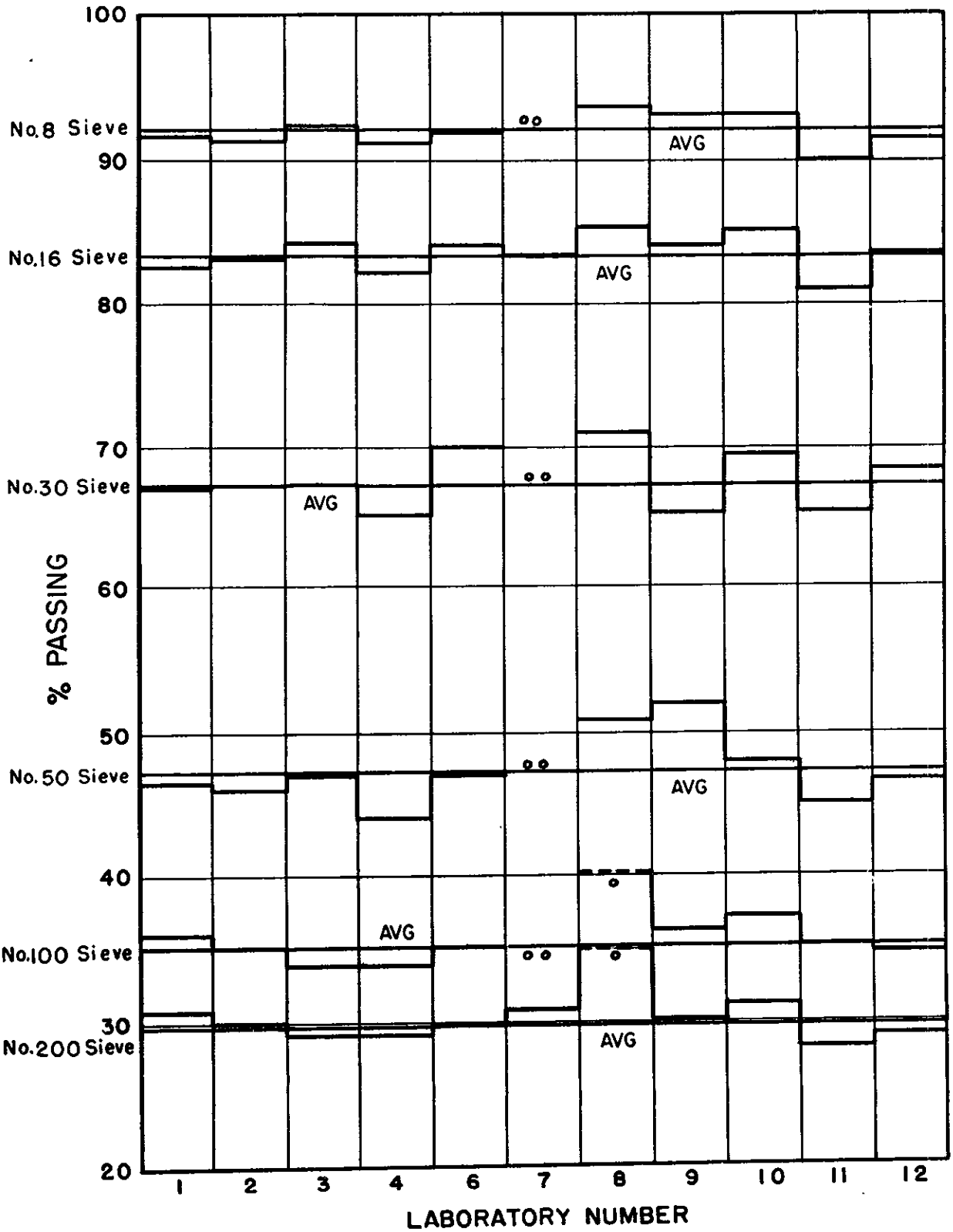


CHART II

MECHANICAL ANALYSIS

SOIL SAMPLE NO. 50-4162A



o Not included in computing Averages
oo Laboratory Averages not reported

PART II - ASPHALTS

Liquid Asphalt SC-3

Cooperative check tests on identical samples of a slow curing asphaltic road material, grade SC-3, were made by eleven western state laboratories. The tests included in this series are as follows:

I Flash Point by means of the Cleveland Open Cup (AASHO T 48-46)
II Viscosity at 140° F by means of the Saybolt Furol Viscosimeter (AASHO T 72-46)
III Residue of 100 penetration (AASHO T 56-42)
IV Distillate to 680° F (AASHO T 78-42)

A tabulation of each state's results on these tests are shown in Table B and Chart III.

Generally, all results showed this material as acceptable under the limits as set forth in AASHO Specifications M 141-49 with the exception of one state's result of the residue of 100 penetration.

A range of 50° was obtained on the Flash Point of this material with eight states within 20° and five states within 10° of the average. The maximum deviation from the average was 29.5°.

Viscosity measurements showed a range of 26 seconds from maximum to minimum. Ten states were within 15 seconds, seven states were within 10 seconds and three states were within 5 seconds of the average. The maximum deviation from the average was 15.9 seconds.

All but one of the nine acceptable results of the per cent residue of 100 penetration were within 1% of the average, and of these, three results were within 0.5% of the average.

In obtaining the amount of distillate after heating to 680° F, a difference of 3.0 ml. was realized from the laboratory averages. All but three states were within 1 ml. and four states were within 0.5 ml. of the average.

85-100 Pen. Asphalt

Cooperative check tests on identical samples of 85-100 penetration asphalt cement were made by eleven western state laboratories. The tests included in this series were:

I Flash Point by means of the Cleveland Open Cup (AASHO T 48-46)
II Original Penetration and Penetration of Residue from Evaporation Loss (AASHO T 49-42)
III Loss on Heating to 325° F (AASHO T 47-42)
IV Heptane Xylene Equivalent

A tabulation of each state's results on these tests is shown in Table C and Chart IV. On the tests reported, all states found this material passed the specifications as set forth in AASHO M 20-42.

From the results of ten states, a range of 50° was obtained in the test for Flash Point. Eight states obtained averages within 20° and four states within 10° of the average.

With the exception of three states, the results of the penetration tests were good, the original penetration showing a variation of 3 and a maximum deviation from the average of 1.6 while the penetration after loss varied 2 with a maximum deviation of 1.3 from the average.

Nine of the ten states reporting the per cent loss at 325° F showed the following results: Maximum deviation from the average of the acceptable results was 0.071 per cent. Five states were within 0.02 per cent of the average and a range of 0.14 per cent was realized.

The Heptane Xylene Equivalent for this material showed a wide range with two states reporting 10-15, one state reporting 15, one state reporting 15-20, three states reporting 20-25, and one state reporting 30-35.

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COOPERATIVE CHECK TEST PROGRAM - 1951
PHYSICAL TESTS ON SC-3 ASPHALTIC ROAD MATERIAL

Table B

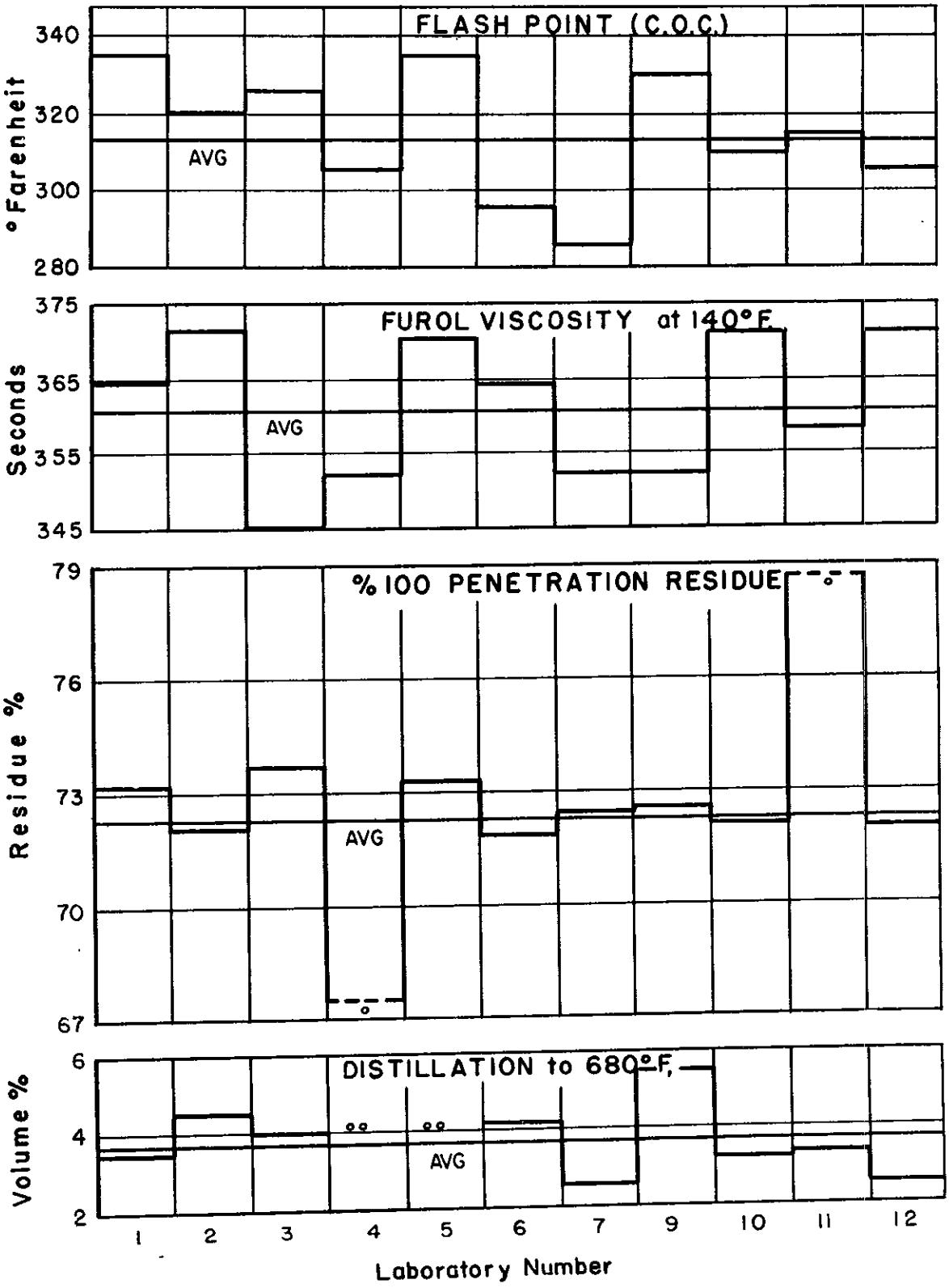
Laboratory	Flash Cleveland Open Cup		Viscosity Saybolt Furol		Residue of 100° Penetration		Distillation to 680°F.	
	Average	% Var.	Average	% Var.	Average	% Var.	Average	% Var.
1	335	+6.5	364	+0.9	73.2	+0.9	3.5	- 5.1
2	320	+1.7	371	+2.8	72.0	-0.8	4.5	+22.0
3	325	+3.3	345	-4.4	73.7	+1.6	4.0	+ 8.4
4	305	-3.0	352	-2.5	67.5*			
5	335	+6.5	370	+2.5	73.3	+1.0		
6	295	-6.2	364	+0.9	71.8	+1.0	4.2	+13.8
7	285	-9.4	352	-2.5	72.4	+0.2	2.5	-32.2
9	330	+4.9	352	-2.5	72.5	-0.1	5.5	+49.1
10	310	-1.4	371	+2.8	72.1	-0.6	3.2	-13.3
11	315	-0.2	358	-0.8	78.7*		3.3	-10.6
12	305	-3.0	371	+2.8	72.0	-0.8	2.5	-32.2
Average	314.5	4.2	360.9	2.3	72.56	0.8	3.69	20.7
Maximum	335	9.4	371	4.4	73.7	1.6	5.5	49.1
Minimum	285	0.2	345	0.8	71.8	0.1	2.5	5.1

*Not included in computing averages

CHART III

TEST RESULTS

SC-3 ASPHALTIC ROAD MATERIAL



° Not in computing Averages

°° Laboratory Average Not Reported

A.A.S.H.O.
COOPERATIVE CHECK TEST PROGRAM - 1951
PHYSICAL TESTS ON 85-100 PENETRATION ASPHALT CEMENT

Table C

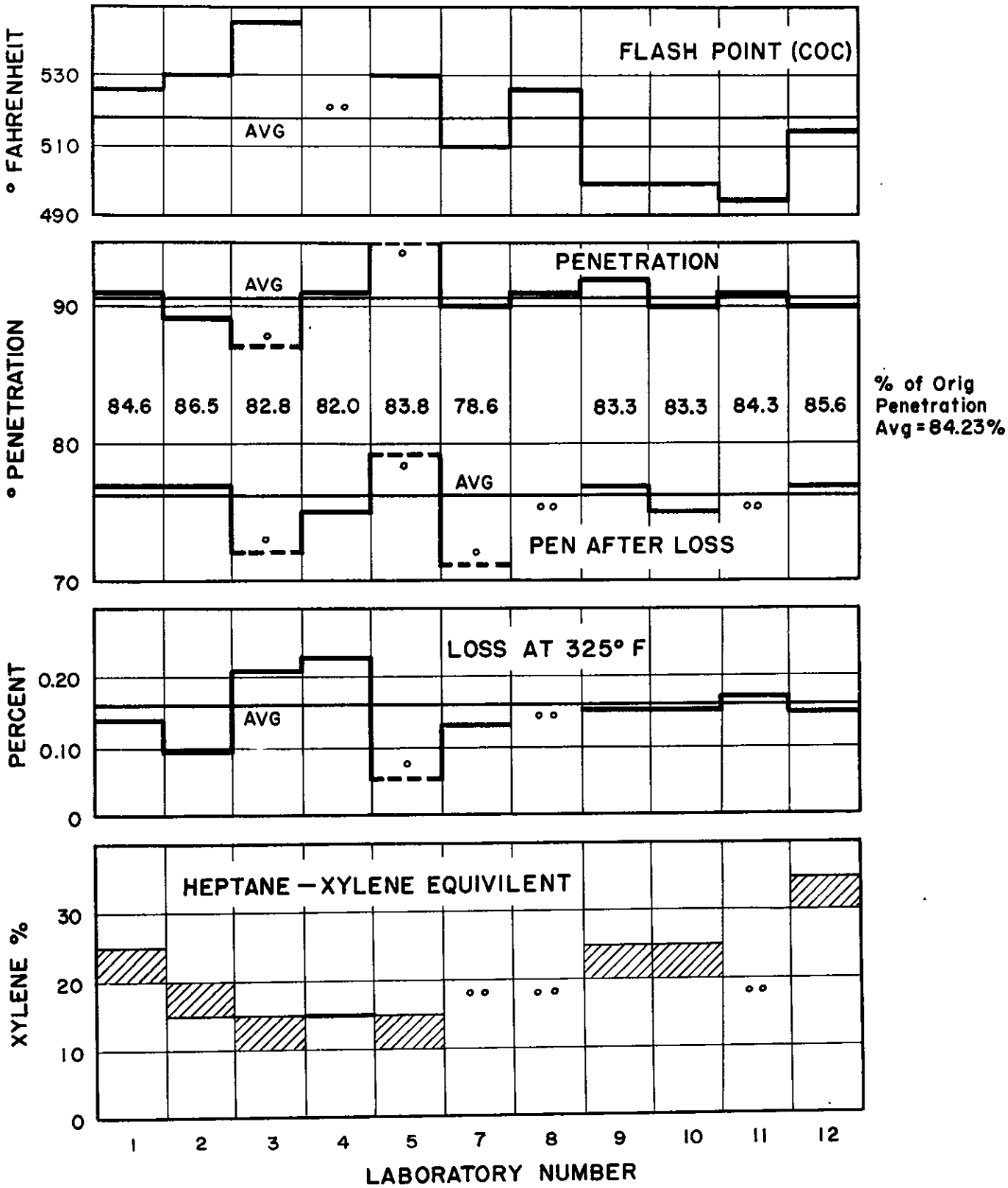
Laboratory	Flash Cleveland Open Cup		Penetration		% Loss at 325°F.		Penetration After Loss		% of Original Penetration		Heptane Xylene Equivalent
	Average	% Var.	Average	% Var.	Average	% Var.	Average	% Var.	Average	% Var.	Average
1	525	+1.4	91	+0.4	0.14	-11.9	77	+0.9	84.6	+ 0.4	20-25
2	530	+2.4	89	-1.8	0.09	-43.4	77	+0.9	86.5	+ 2.7	15-20
3	545	+5.3	87*		0.21	+32.1	72**		82.8**		10-15
4	400*		91	+0.4	0.23	+44.7	75	-1.7	82.0	+ 2.6	15
5	530	+2.4	95*		0.05*		79**		83.8**		10-15
7	510	-1.4	90	-0.7	0.13	-18.2	71*		78.6**		
8	525	+1.4	91	+0.4							
9	500	-3.4	92	+1.5	0.15	- 5.7	77	+0.9	83.3	- 1.1	20-25
10	500	-3.4	90	-0.7	0.15	- 5.7	75	-1.7	83.3	- 1.1	20-25
11	495	-4.3	91	+0.4	0.17	+ 6.9			84.3	+ 0.1	
12	515	-0.5	90	-0.7	0.16	+ 0.6	77	+0.9	85.6	+11.6	30-35
Average	517.5	2.6	90.6	0.8	0.159	18.8	76.3	1.2	84.23	1.4	
Maximum	545	5.3	92	1.8	0.23	44.7	77	1.7	86.5	2.7	
Minimum	495	0.5	89	0.4	0.09	0.6	75	0.9	82.0	0.1	

*Not used in computing averages
**Not used in computing averages--rejected because of inconsistency of associated test results

CHART IV

TEST RESULTS

85-100 PENETRATION ASPHALTIC CEMENT



° Not used in computing avg

°° Laboratory avg not reported

PART III - PORTLAND CEMENT

Cooperative check tests of seven different Portland cement samples were performed by nine western state laboratories. The tests included in this series were as follows:

I Complete Chemical Analysis, including Alkali Determination (AASHO T 105-48). Six states reported results partially or in full.

II Autoclave Expansion (AASHO T 107-49). Eight states reported results.

III Setting Time by Use of Gilmore Needles (AASHO T 131-49). Nine states reported results.

IV Surface Area by Wagner Turbidimeter (AASHO T 98-45). Seven states reported results.

V Compressive Strength at 3, 7, and 28 days (AASHO T 106-49). Eight states reported results partially or in full.

VI Tensile Strength at 3, 7, and 28 days (AASHO T 132-49). Nine states reported results partially or in full.

Tabulations of each state's results on the chemical analysis of each cement sample are shown in Table E and Charts V through XV, inclusive. Tabulations of state's results on the physical tests are shown in Table F and Charts XVI through XX, inclusive. In addition to the above tests, three states reported results on the Normal Consistency (AASHO T 129-42), and Surface Area by Blaine Air Permeability (ASTM C-204-46T), which are shown in Table F for information only.

Table D is a recapitulation of the averages of individual acceptable tests performed on each cement sample. The average deviations on this table are the arithmetic means of the deviations from the average of tests performed on each sample. For convenience, an average deviation for each test covering all seven cement samples is included.

Generally, with the exception of the results not included in the average, the chemical analyses as reported by each state show good reproducibility between laboratories. In regard to the relatively large deviations in the determination for aluminum oxide (Al_2O_3), it must be remembered that the amount of this oxide is determined by deducting the amount of Ferric Oxide (Fe_2O_3), a comparatively close determination, from the R_2O_3 (Al_2O_3+ Fe_2O_3 + minor oxides). It can easily be seen that this procedure would appreciably increase the errors encountered in calculating the amount of aluminum oxide present.

Of the 52 acceptable results of the Autoclave Expansion Test for Soundness, 37 of these were within 0.015 per cent and 27 were within 0.01 per cent of the average. See Chart XVI.

The results obtained in performing the test for Time of Set reflect very greatly the skill of the operator. With this in consideration, the results were generally good as shown in Chart XVII. Of the 125 acceptable results on Initial and Final Setting Times, 79 were within 15 per cent and 55 were within 10 per cent of their respective averages.

Seven states tested each of the seven cement samples for fineness by the Wagner Turbidimeter (Chart XVIII). Of the 47 acceptable results, 15 were within 25 sq. cm/gram, 26 were within 50 sq. cm/gram, and 35 were within 75 sq. cm/gram of their respective averages. Of the remaining 12 results, 3 exceeded 100 sq. cm/gram from their averages.

The results obtained on the Compressive Strength (Chart XIX) and Tensile Strength (Chart XX) of each of the seven cement samples showed fair correlation between state laboratories. It is noted from Table F, the average variations exceeded 10 per cent a total of eight times on the 42 tests performed.

A.A.S.H.O.
COOPERATIVE CHECK TEST PROGRAM - 1951
AVERAGE RESULTS OF TESTS PERFORMED ON PORTLAND CEMENT

Table D

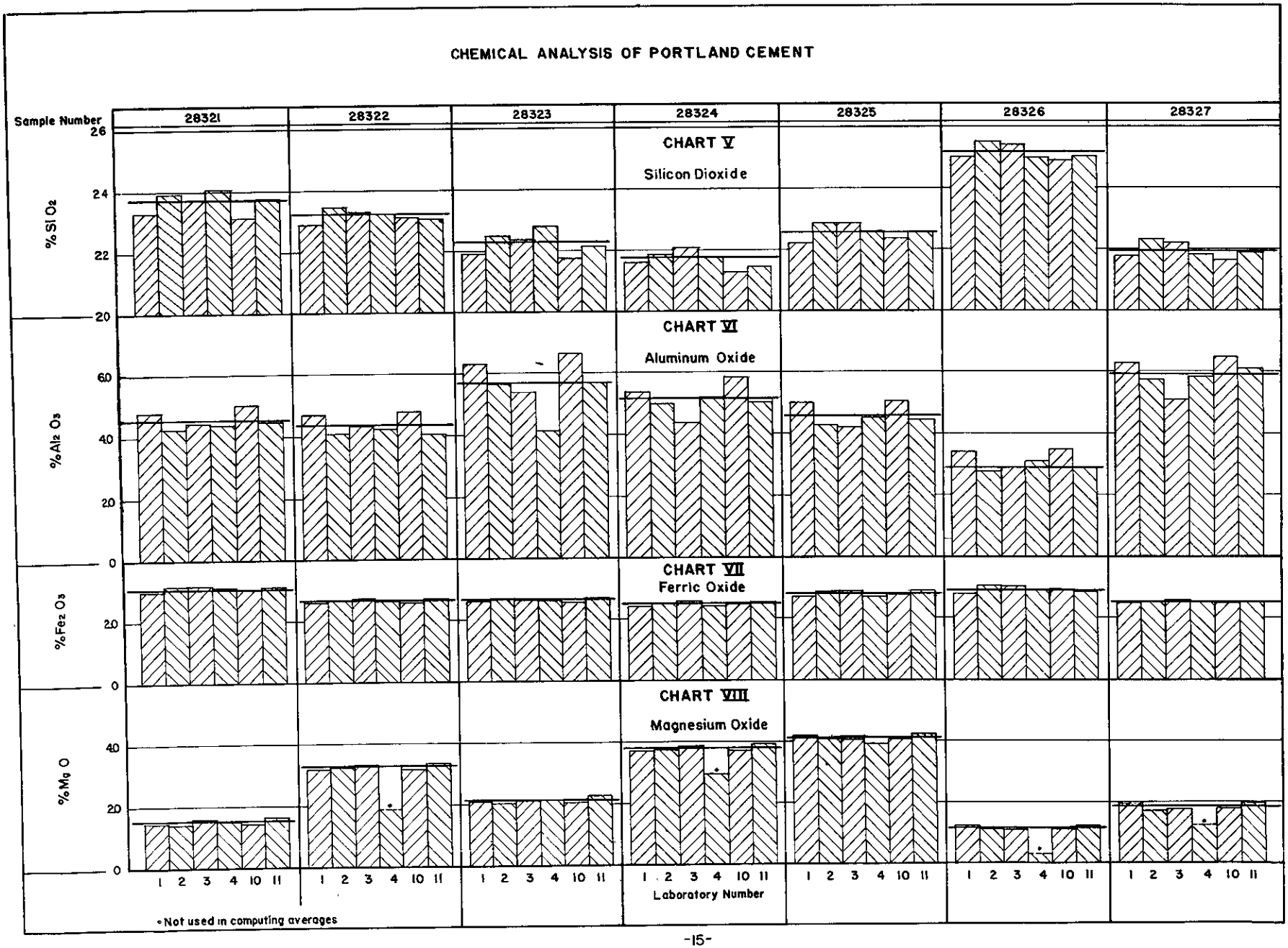
Test Performed	unit	Cement Sample No. 28321		Cement Sample No. 28322		Cement Sample No. 28323		Cement Sample No. 28324		Cement Sample No. 28325		Cement Sample No. 28326		Cement Sample No. 28327		Average Deviation
		Average	Av. Dev.	Average	Av. Dev.	Average	Av. Dev.	Average	Av. Dev.	Average	Av. Dev.	Average	Av. Dev.	Average	Av. Dev.	
I CHEMICAL																
SiO_2	%	23.73	0.180	23.202	0.182	22.250	0.320	21.647	0.193	22.567	0.208	25.147	0.226	21.958	0.214	0.218
Al_2O_3	%	4.558	0.238	4.365	0.260	5.627	0.578	5.150	0.320	4.558	0.301	3.078	0.248	5.93	0.370	0.331
Fe_2O_3	%	3.068	0.062	2.657	0.050	2.648	0.052	2.465	0.052	2.778	0.062	2.918	0.071	2.507	0.033	0.055
CaO	%	64.086	0.047	63.286	0.173	63.324	0.111	63.952	0.074	62.684	0.221	65.036	0.261	63.990	0.190	0.154
MgO	%	1.512	0.059	3.258	0.070	2.135	0.055	3.788	0.062	4.123	0.072	1.180	0.050	1.880	0.100	0.067
SO_3	%	1.054	0.027	1.472	0.022	2.053	0.026	2.144	0.025	1.657	0.033	1.644	0.019	2.116	0.009	0.023
Ignition Loss	%	1.806	0.049	1.556	0.033	0.878	0.098	0.803	0.079	1.320	0.117	0.640	0.060	0.907	0.119	0.079
Insoluble Residue	%	0.207	0.058	0.182	0.042	0.152	0.038	0.183	0.083	0.126	0.031	0.136	0.031	0.092	0.022	0.044
Na_2O	%	0.322	0.014	0.166	0.013	0.580	0.020	0.114	0.006	0.398	0.018	0.168	0.018	1.136	0.045	0.019
K_2O	%	0.302	0.028	0.580	0.010	0.764	0.043	0.460	0.020	0.226	0.019	0.258	0.015	0.060	0.010	0.021
Alkali	%	0.520	0.030	0.542	0.018	1.078	0.034	0.420	0.010	0.544	0.027	0.336	0.023	1.174	0.051	0.028
II PHYSICAL																
Autoclave	%	0.0164	0.0077	0.0688	0.0060	0.0829	0.0089	0.227	0.0194	0.294	0.0380	-0.009	0.0083	0.124	0.0090	0.0139
Initial Set	min.	190	20	218	15	179	16	173.5	25	223	44	159	38	128	22	26
Final Set	Min.	300	36	336	20	290	39	333	39	370	39	286	46	239	39	37
Wagner	Cm^2/gm	1708	17	1799	54	1810	48	1695	60	1817	59	1873	40	1658	48	47
Blaine	Cm^2/gm	3343	44	3381	33	3357	23	3174	21	3299	86	3240	88	3223	13	44
COMPRESSION																
3 days	psi	943	24	1097	98	1796	172	1719	117	1584	143	1380	80	1472	196	119
7 days	psi	1567	188	1720	129	2875	205	2973	206	2491	395	1978	158	2324	289	224
28 days	psi	2995	223	3490	272	4208	315	4573	505	3659	507	3260	323	3368	197	335
TENSION																
3 days	psi	222	21	240	31	321	28	330	8	310	15	265	25	312	9	20
7 days	psi	304	32	325	25	418	16	401	10	389	20	373	15	381	14	19
28 days	psi	417	28	465	25	478	31	491	29	491	21	478	28	432	24	27

A.A.S.H.O.
COOPERATIVE CHECK TEST PROGRAM - 1951
PORTLAND CEMENT - CHEMICAL TESTS

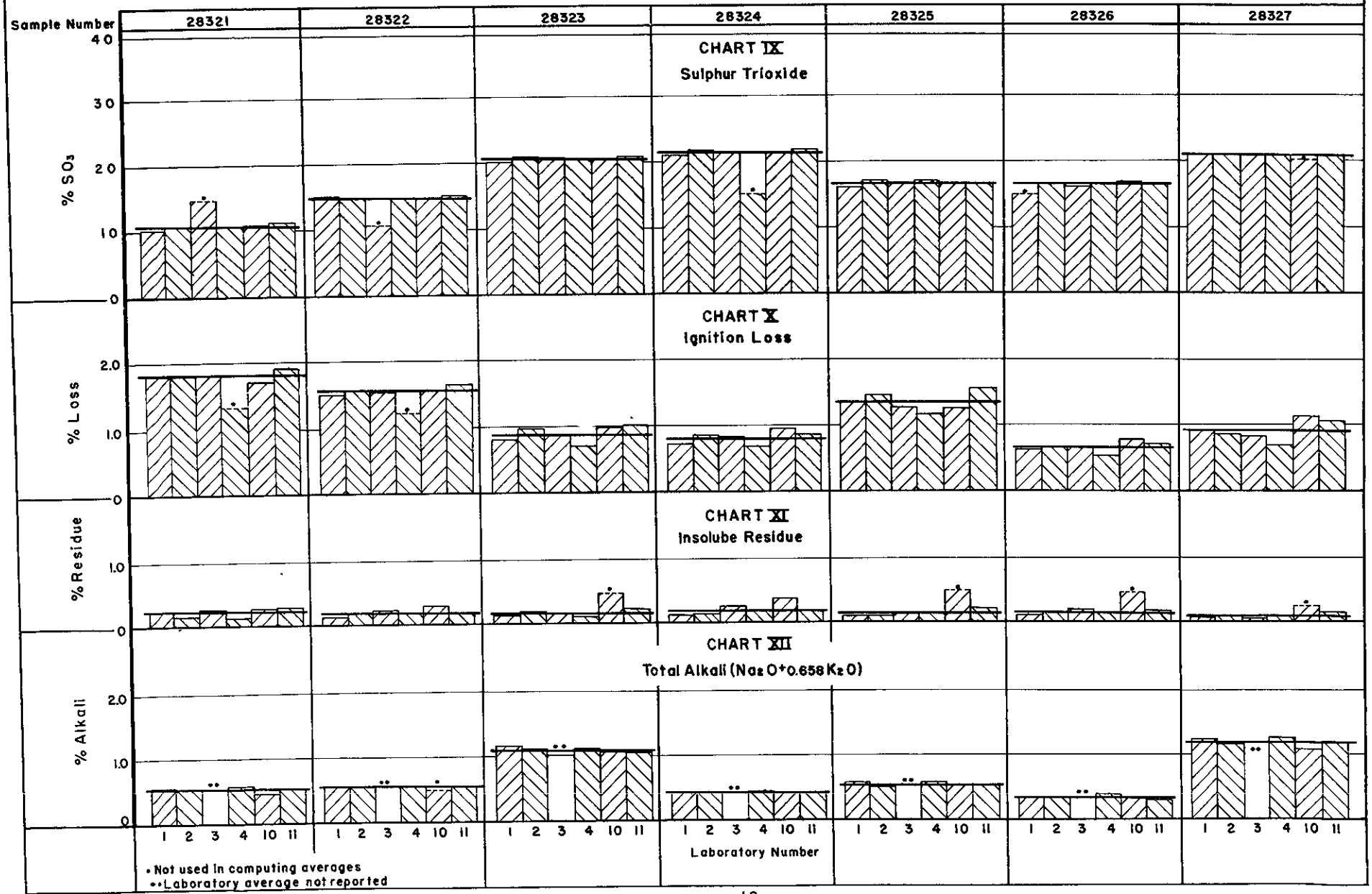
Table 8

Laboratory	SiO_2 Silicon Dioxide		Al_2O_3 Aluminum Oxide		Fe_2O_3 Ferric Oxide		CaO Calcium Oxide		MgO Magnesium Oxide		SO_3 Sulphur Trioxide		Ignition Loss		Insoluble Residue		Na_2O*** Sodium Oxide		K_2O*** Potassium Oxide		Total Alkali*** [Na_2O + 0.658 K_2O]		C_4AF Tetra Calcium Alumina Ferrite		C_3A Tricalcium Aluminate		$CaSO_4$ Calcium Sulfate		C_3S Tricalcium Silicate		C_2S Dicalcium Silicate	
	%	% Var.	%	% Var.	%	% Var.	%	% Var.	%	% Var.	%	% Var.	%	% Var.	%	% Var.	%	% Var.	%	% Var.	%	% Var.	%	% Var.	%	% Var.	%	% Var.	%	% Var.	%	% Var.
																	Sample No. 28321															
1	23.3	-1.8	4.8	+5.3	3.0	-2.2	64.2	+0.2	1.5	-0.8	1.0	-5.1	1.8	-0.3	0.21	+ 1.4	0.34	+5.6	0.31	+ 2.6	0.54	+ 3.8	9.0	-4.3	8.0	+14.3	2.0	+5.3	45.0	+5.4	33.0	-7.6
2	23.94	+0.9	4.23	-7.2	3.16	+3.0	64.08	0.0	1.41	+6.7	1.06	+0.6	1.82	+0.8	0.13	+37.2	0.32	-0.6	0.31	+ 2.6	0.52	0.0	10.0	+6.4	6.0	-14.3	2.0	+5.3	43.0	+0.7	35.0	+0.8
3	23.74	+0.0	4.43	-2.8	3.15	+2.7	64.08	0.0	1.54	-1.9	1.45*		1.82	+0.8	0.25	-20.8							10.0	+6.4	6.0	-14.3	3.0**		42.0**		36.0**	
4	24.02	+1.2	4.39	-3.7	3.03	-1.2	63.62*		1.50	-0.8	1.04	-1.3	1.31*		0.11	-46.9	0.34	+5.6	0.36	+19.2	0.57	+ 9.6	9.3	-1.1	6.6	- 5.7	1.7	-10.5	39.5**		39.0**	
10	23.63	-0.4	5.03	+10.6	2.99	-2.5	63.98	-0.2	1.46	-3.4	1.06	+0.6	1.69	-6.4	0.26	+25.6	0.29	-9.9	0.24	-20.5	0.45	-13.5	9.0	-4.3	8.37	+18.6	2.0	+ 5.3	39.8	-5.9	37.8	+5.9
11	23.75	+0.1	4.47	-1.9	3.08	+0.4	64.09	0.0	1.66	+9.8	1.11	+5.3	1.90	+5.2	0.28	+35.3	0.32	-0.6	0.30	- 0.7	0.52	- 0.0	9.0	-4.3	7.0	0.0	2.0	+ 5.3	43.0	+0.7	36.0	+0.8
Average	23.73	0.7	4.558	5.2	3.068	2.0	64.086	0.1	1.512	3.9	1.054	2.6	1.806	2.7	0.207	27.9	0.322	4.5	0.302	9.1	0.520	5.4	9.4	4.5	7.0	11.2	1.9	6.3	42.7	3.2	35.7	3.8
Maximum	24.02	1.8	5.03	10.6	3.16	3.0	64.2	0.2	1.66	9.8	1.11	5.3	1.90	6.4	0.28	46.9	0.34	9.9	0.36	20.5	0.57	13.5	10.0	6.4	8.37	18.6	2.0	10.5	45.0	5.9	37.8	7.6
Minimum	23.3	0.0	4.23	1.9	2.99	0.4	63.98	0.0	1.41	0.8	1.0	0.6	1.69	0.3	0.11	1.4	0.29	0.6	0.24	0.7	0.45	0.0	9.0	1.1	6.0	0.0	1.7	5.3	39.8	0.7	36.0	0.8
																	Sample No. 28322															
1	22.9	-1.3	4.7	+ 7.7	2.6	-2.1	63.5	+0.3	3.2	-1.8	1.5	+1.9	1.5	-3.6	0.11	-39.6	0.18	+8.4	0.58	0.0	0.56	+3.3	8.0	0.0	8.0	+14.3	3.0	+11.1	45.0	+2.0	32.0	-3.3
2	23.47	+1.2	4.08	- 6.5	2.69	+1.2	63.08	+0.3	3.21	-1.5	1.47	-0.1	1.56	+0.3	0.17	- 6.6	0.15	-9.6	0.59	+1.7	0.53	-2.2	8.0	0.0	6.0	-14.3	3.0	+11.1	43.0	-2.5	35.0	+5.7
3	23.28	+0.3	4.34	- 0.6	2.72	+2.4	63.38	-0.1	3.31	+1.6	1.04*		1.53	-1.7	0.21	+15.4							8.0	0.0	7.0	0.0	2.0**		45.0**		33.0*	
4	23.4	+0.9	4.22	- 3.3	2.62	-1.4	62.53*		1.91*		1.47	-0.1	1.21*		0.15	-17.6	0.18	+8.4	0.59	+1.7	0.56	+3.3	7.8	-2.5	6.5	- 7.1	2.5	- 7.4	40.4*		37.5**	
10	23.11	-0.4	4.81	+10.2	2.60	-2.1	63.41	+0.2	3.29	+2.1	1.42	-3.5	1.56	+0.3	0.28	+53.8	0.17	+2.4	0.48*		0.49**		8.0	0.0	8.4	+20.0	2.0	-25.9	42.4*	-3.9	34.4	+3.9
11	23.05	-0.7	4.04	- 7.4	2.71	+2.0	63.06	-0.4	3.38	+3.7	1.50	+1.9	1.63	+4.8	0.17	- 6.6	0.15	-9.6	0.56	-3.4	0.52	-4.1	8.0	0.0	6.0	-14.3	3.0	+11.1	46.0	+4.3	31.0	-6.3
Average	23.202	0.8	4.365	6.0	2.657	1.9	63.286	0.3	3.258	2.1	1.472	1.5	1.556	2.1	0.182	23.3	0.166	7.7	0.580	1.7	0.542	3.2	8.0	0.4	7.0	11.7	2.7	13.3	44.1	3.2	33.1	4.8
Maximum	23.47	0.3	4.81	10.2	2.72	2.4	63.5	0.4	3.38	3.7	1.50	3.5	1.63	4.8	0.28	53.8	0.18	9.6	0.59	3.4	0.56	2.2	8.0	2.5	8.4	20.0	3.0	25.9	46.0	4.3	35.0	6.3
Minimum	22.9	1.3	4.04	0.6	2.60	1.2	63.06	0.1	3.19	1.5	1.42	0.1	1.5	0.3	0.11	6.6	0.15	2.4	0.56	0.0	0.52	4.1	7.8	0.0	6.0	0.0	2.0	7.4	42.4*	2.0	31.0	3.3
																	Sample No. 28323															
1	21.9	-1.6	6.3	+12.0	2.6	-1.8	63.4	+0.1	2.1	-1.6	2.0	-2.6	0.8	-8.9	0.11	-27.6	0.63	+8.6	0.79	+3.4	1.14	+5.8	8.0	0.0	12.0	+16.5	3.0	-16.7	40.0	-0.2	33.0	-1.5
2	22.51	+1.2	5.63	+ 0.1	2.69	+1.6	63.41	+0.1	2.03	-4.9	2.08	+1.3	0.95	+8.2	0.18	+18.6	0.58	-0.0	0.77	+0.8	1.08	+0.2	8.0	0.0	10.0	- 2.9	4.0	+11.1	40.0	-0.2	35.0	+4.5
3	22.40	+0.7	5.38	- 4.4	2.70	+2.0	63.26	-0.1	2.14	+0.2	2.07	+0.8	0.85	-3.2	0.16	+ 5.3							8.0	0.0	10.0	- 2.9	4.0	+11.1	41.0	+2.2	33.0	-1.5
4	22.8	+2.5	4.14	-26.4	2.60	-1.8	62.28*		2.16	+1.2	2.06	+0.3	0.69	-21.4	0.10	-34.2	0.55	-5.2	0.84	+9.9	1.10	+2.0	7.8	-2.5	6.5	-36.9	3.5	- 2.8	42.8**		33.1**	
10	21.76	-2.2	6.65	+18.2	2.59	-2.2	63.44	+0.2	2.11	-1.2	2.03	-1.1	0.98	+11.6	0.44*		0.58	0.0	0.70	-8.4	1.04	-3.5	8.0	0.0	13.2	+28.2	3.0	-16.7	38.6	-3.7	33.3	-0.6
11	22.13	-0.5	5.66	+ 0.6	2.71	+2.3	63.11	-0.3	2.27	+5.3	2.08	+1.3	1.00	+13.9	0.21	+38.2	0.56	-3.4	0.72	-5.8	1.03	-4.5	8.0	0.0	10.0	- 2.9	4.0	+11.1	41.0	+2.2	33.0	-1.5
Average	22.250	1.4	5.627	10.3	2.648	2.0	63.324	0.2	2.135	2.6	2.053	1.2	0.878	11.2	0.152	24.7	0.580	3.4	0.764	5.7	1.078	3.2	8.0	0.4	10.3	15.1	3.6	11.6	40.1	1.7	33.5	1.9
Maximum	22.8	2.5	6.65	26.4	2.71	2.3	63.44	0.3	2.27	6.3	2.08	2.6	1.00	21.4	0.21	38.2	0.63	8.6	0.84	9.9	1.14	5.8	8.0	2.5	13.2	36.9	4.0	16.7	41.0	3.7	35.0	4.5
Minimum	21.76	0.5	4.14	0.1	2.59	1.6	63.11	0.1	2.03	0.2	2.0	0.3	0.69	3.2	0.10	5.3	0.55	0.0	0.70	0.8	1.03	0.2	7.8	0.0	6.5	2.9	3.0	2.8	38.6	0.2	33.0	0.6
																	Sample No. 28324															
1	21.6	-0.2	5.4	+0.5	2.4	-2.6	64.1	+0.2	3.7	-2.3	2.1	-2.1	0.7	-12.8	0.11	-39.9	0.11	- 3.5	0.47	+ 2.2	0.42	0.0	7.0	-6.7	8.0	-11.1	4.0	0.0	51.0	-1.5	24.0	+3.0
2	21.84	+0.9	4.99	-0.3	2.49	+1.0	63.94	-0.0	3.76	+0.7	2.17	+1.2	0.85	+ 5.9	0.12	-34.4	0.11	- 3.5	0.45	- 2.2	0.42	0.0	8.0	+6.7	9.0	0.0	4.0	0.0	51.0	-1.5	24.0	+3.0
3	21.98	+1.5	4.38	-1.5	2.58	+4.7	63.90	-0.1	3.79	+0.1	2.13	-0.7	0.81	+ 0.9	0.24	+31.1							8.0	+6.7	7.0	-22.2	4.0	0.0	54.0	+4.2	23.0	-1.3
4	21.7	+0.2	5.2	+0.1	2.4	-2.6	62.71*		2.99*		1.5*		0.67	-16.6	0.07	-61.7	0.11	- 3.5	0.50	+ 8.7	0.44	+4.8	7.3	-2.7	9.5	+ 5.6	2.5**		47.6**		26.3**	
10	21.29	-1.6	5.82	+1.3	2.44	-1.0	63.99	+0.1	3.75	-1.0	2.14	-0.2	0.93	+15.8	0.37	202.2	0.13	-14.0	0.41	-10.9	0.40	-4.8	7.0	-6.7	11.3	+14.4	4.0	0.0	50.0	-3.5	23.4	+0.4
11	21.47	-0.8	5.11	-0.1	2.48	+0.6	63.83	-0.2	3.94	+4.0	2.18	+1.7	0.86	+ 7.1	0.19	+ 3.8	0.11	- 3.5	0.47	+ 2.2	0.42	0.0	8.0	+6.7	9.0	0.0	4.0	0.0	53.0	+2.3	22.0	-5.6
Average	21.647	0.9	5.150	0.6	2.469	2.1	63.952	0.1	3.788	1.4	2.144	1.2	0.803	9.8	0.183	45.5	0.114	5.6	0.460	5.2	0.420	1.9	7.5	6.0	9.0	8.9	4.0	0.0	51.8	2.6	23.3	2.7
Maximum	21.98	1.6	5.82	1.5	2.58	4.7	64.1	0.2	3.94	4.0	2.18	2.1	0.93	16.6	0.37	102.2	0.13	14.0	0.50	10.9	0.44	4.8	8.0	6.7	11.3	22.2	4.0	0.0	54.0	4.2	24.0	5.6
Minimum	21.29	0.2	4.38	0.1	2.4	0.6	63.83	0.0	3.7	0.1	2.1	0.2	0.67	0.9	0.07	3.8	0.11	3.5	0.41	2.2	0.40	0.0	7.0	2.7	7.0	0.0	4.0	0.0	50.0	1.5	22.0	0.4
																	Sample No. 28325															
1	22.2	-1.6	5.0	+9.7	2.7	-2.8	63.9*		4.2	+1.9	1.6	-3.4	1.3	- 1.5	0.09	-28.6	0.42	+5.5	0.23	+ 1.8	0.57	+4.8	8.0	-8.0	9.0	+23.3	3.0	0.0	49.0**		26.0**	
2	22.85	+1.3	4.23	-7.2	2.85	+2.6	62.91	+0.4	4.07	-1.3	1.70	+2.6	1.45	+ 9.8	0.10	-20.6	0.36	-9.5	0.21	- 7.1	0.50	-8.1	9.0	+3.4	6.0	-17.8	3.0	0.0	45.0	+1.8	32.0	+0.9
3	22.84	+1.2	4.18	-8.3	2.86	+3.0	62.36	-0.5	4.13	+0.2	1.67	+0.8	1.26	- 4.5	0.13	+ 3.2							9.0	+3.4	6.0	-17.8	3.0	0.0	43.0	-3.6	33.0	+4.1
4	22.6	+0.1	4.50	-1.3	2.7	-2.8	62.5	-0.3	3.96	-4.0	1.7	+2.6	1.14	-13.6	0.11	-12.7	0.41	+3.0	0.27	+19.5	0.58	+6.6	8.2	-5.7	7.4	+ 1.4	2.8	-6.7	43.6	-1.4	32.0	+0.9
10	22.31	-1.1	5.02	+10.1	2.75	-1.0	63.01	+0.5	4.13	+0.2	1.63	-1.6	1.23	- 6.8	0.48*		0.39	-2.0	0.20	-11.5	0.52	-4.4	9.0	+3.4	8.6	+17.8	3.0	0.0	44.6	+0.9	30.4	-4.1
11	22.60	+0.1	4.42	-3.0	2.81	+1.2	62.64	+0.1	4.25	+3.1	1.64	-1.0	1.54	+16.7	0.20	+58.7	0.41	+3.0	0.22	- 2.7	0.55	+1.1	9.0	+3.4	7.0	- 4.1	3.0	0.0	45.0	+1.8	31.0	-2.2
Average	22.567	0.9	4.558	6.6	2.778	2.2	62.684	0.4	4.123	1.8	1.657	2.0	1.320	8.8	0.126	24.8	0.398	4.6	0.226	8.5	0.544	5.0	8.7	4.6	7.3	13.7	3.0	1.1	44.2	1.9	31.7	2.4
Maximum	22.85	1.6	5.02	10.1	2.86	3.0	63.01	0.5	4.25	4.0	1.70	3.4	1.54	16.7	0.20	58.7	0.42	9.5	0.27	19.5	0.58	8.1	9.0	8.0	9.0	23.3	3.0	6.7	45.0	3.6	33.0	4.1
Minimum	22.2	0.1	4.18	1.3	2.7	1.0	62.36	0.1	3.96	0.2	1.6	0.8	1.14	1.5	0.09	3.2	0.36	2.0	0.20	1.8	0.50	1.1	8.0	3.4	6.0	1.4	2.8	0.0	43.0	0.9	30.4	0.9
																	Sample No. 28326															
1	25.0	-0.6	3.4	+10.5	2.8	-4.0	66.8*		1.2	+1.7	1.5*		0.6	-6.2	0.10	-26.5	0.17	+ 1.2	0.26	+ 0.8	0.34	+ 1.2	9.0	0.0	2.0	-31.0	3.0**		51.0**		33.0**	
2	25.57	+1.7	2.73	-11.3	3.03	+3.8	65.28	+0.4	1.13	-4.2	1.64	-0.2	0.65	+1.6	0.12	-11.8	0.16	- 4.8	0.26	+ 0.8	0.32	- 4.8	9.0	0.0	2.0	-31.0	3.0	+3.4	44.0	-0.2	40.0	+3.1
3	25.40	+1.0	2.88	- 6.4	3.02	+3.5	65.30	+0.4	1.11	-5.9	1.61	-2.1	0.62	-3.1	0.18	+32.4							9.0	0.0	3.0	+ 3.4	3.0	+3.4	44.0	-0.2	39.0	+0.5
4	24.98	-0.7	3.11	+ 1.0	2.91	-0.3	64.68	-0.5	0.38*		1.64	-0.2	0.51	-20.3	0.11	-19.1	0.20	+19.0	0.29	+12.4	0.39	+16.1	8.8	-2.2	3.0	+ 3.4	2.70	-6.9	43.6	-1.1	39.0	+0.5
10	24.91	-0.9	3.47	+12.7	2.85	-2.3	64.74	-0.5	1.19	+0.8	1.69	+2.9	0.77	+20.3	0.44*		0.18	+ 7.1	0.22	-14.7	0.33	- 1.8	9.0	0.0	4.4	+51.7	3.0	+3.4	42.0	-4.8	39.8	+2.6
11	25.02	-0.5	2.88	- 6.4	2.90	-0.6	65.18	+0.2	1.27	+7.6	1.64	-0.2	0.69	+ 7.8	0.17	+25.0	0.13	-22.6	0.26	+ 0.8	0.30	-10.7	9.0	0.0	3.0	+ 3.4	3.0	+3.4	47.0	+5.6	36.0	-7.2
Average	25.147	0.9	3.078	8.1	2.918	2.4	65.036	0.4	1.180	4.0	1.644	1.1	0.64	9.9	0.136	23.0	0.168	10.9	0.258	5.9	0.336	6.9	9.0	0.4	2.9	20.7	2.9	4.1	44.1	2.6	38.8	2.8
Maximum	25.57	1.7	3.47	12.7	3.03	4.0	65.30	0.5	1.27	7.6	1.69	2.9	0.77	20.3	0.18	32.4	0.20	22.6	0.29	14.7	0.39	16.1	9.0	2.2	4.4	51.7	3.0	6.9	47.0	6.5	40.0	7.2
Minimum	24.91	0.5	2.73	1.0	2.8	0.3	64.68	0.2	1.11	0.8	1.61	0.2	0.51	1.6	0.10	11.8	0.13	1.2	0.22	0.8	0.30	1.2	8.8	0.0	2.2	3.4	2.7	3.4	43.6	0.2	36.0	0.5
																	Sample No. 28327															
1	21.8	-0.7	6.3	+ 6.2	2.5	-0.3	65.2*		2.0	+6.4	2.1	-0.8	0.9	-0.8	0.07	-23.9	1.19	+4.8	0.06	0.0	1.22	+3.9	8.0	+2.6	13.0	+13.0	4.0	+ 2.6	48.0**		26.0**	
2	22.34	+1.7	5.73	- 3.4	2.53	+0.9	64.14	+0.2	1.76	-6.4	2.12	+0.2	0.86	-5.2	0.09	- 2.2	1.12	-1.4	0.04	-33.3	1.15	-2.0	8.0	+2.6	11.0	- 4.3	4.0	+ 2.6	44.0	-2.2	31.0	+3.7
3	22.22	+1.2	5.12	-13.7	2.58	+2.9	64.30	+0.5	1.80	+4.3	2.12	+0.2	0.83	+8.5	0.06	-34.8							8.0	+2.6	9.0	-21.7	4.0	+ 2.6	49.0	+8.9	27.0	-9.7
4	21.84	-0.5	5.83	- 1.7	2.51	+0.1	63.6	-0.6	1.31*		2.11	-0.3	0.68	-25.0	0.10	- 8.7	1.19	+4.8	0.08	+33.3	1.24	+5.6	7.6	-2.6	11.2	- 2.6	3.5	-10.3	44.1	-2.0	30.5	+2.0
10	21.65	-1.4	6.49	+ 9.4	2.44	-2.7	64.00	+0.0	1.83	-2.5	2.04*		1.12	+23.5	0.26*		1.04	-8.5	0.05	-16.7	1.07	-8.9	7.0	+10.3	13.0	+13.0	3.0**		42.96*		29.7	
11	21.9	-0.3	6.11	+ 3.0	2.48	-1.1	63.91	-0.1	2.01	+6.9	2.13	+0.7	1.05	+15.8	0.14	+52.2	1.14	+0.4	0.07	+16.7	1.19	+1.4	8.0	+2.6	12.0	+ 4.3	4.0	+ 2.6	43.0	-4.4	31.0	+3.7
Average	21.958	1.0	5.93	6.2	2.507	1.3	63.990	0.3	1.880	5.3	2.116	0.4	0.907	13.1	0.092	24.4	1.136	4.0	0.06	20.0	1.174	4.4	7.8	3.9	11.5	9.6	3.9	4.1	45.0	4.4	29.9	4.8
Maximum	22.34	1.7	6.49	13.7	2.58	2.9	64.30	0.6	2.01	6.9	2.13	0.8	1.12	25.0	0.14	52.2	1.19	8.5	0.08	33.3	1.24	8.9	8.0	10.3	13.0	21.7	4.0	10.3	49.0	8.9	31.0	9.7
Minimum	21.65	0.3	5.12	1.7	2.44	0.1	63.6	0.0	1.76	2.5	2.1	0.2	0.68	0.8	0.06	2.2	1.04	0.4	0.04	0.0	1.07	1.4	7.0	2.6	9.0	2.6	3.5	2.6	43.0	2.0	27.0	2.0

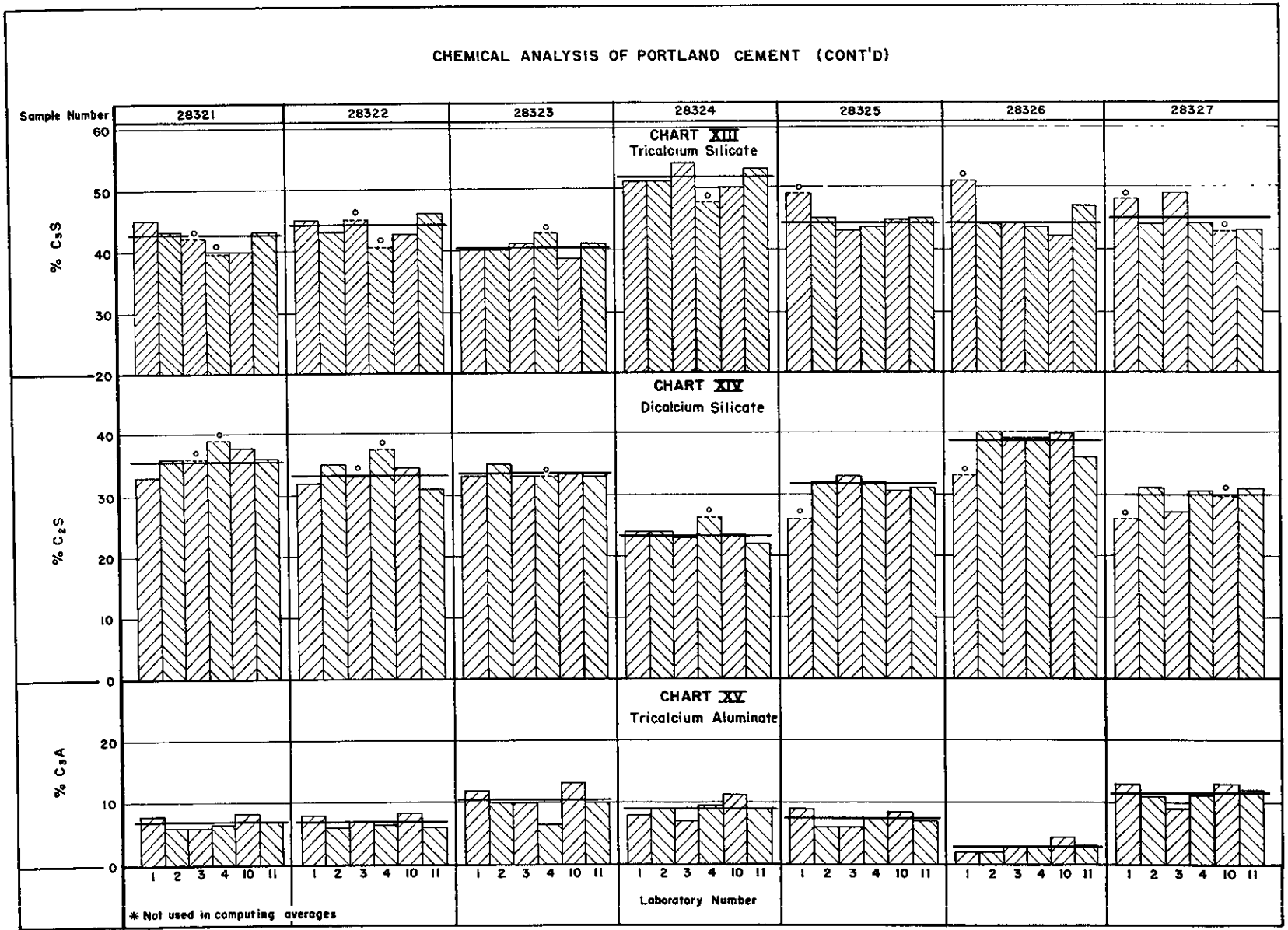
*Not used in computing averages .
**Not used in computing averages--rejected because of inconsistency of test results used in computing compounds
***Flame Photometer Method



CHEMICAL ANALYSIS OF PORTLAND CEMENT (CONT'D)



CHEMICAL ANALYSIS OF PORTLAND CEMENT (CONT'D)



A.A.S.H.O.
COOPERATIVE CHECK TEST PROGRAM - 1951
PHYSICAL TESTS ON PORTLAND CEMENT

Table F

Laboratory	Normal Consistency		Soundness Autoclave		Time of Set Initial		Time of Set Final		Fineness-Spec. Surf. Wagner		Fineness-Spec. Surf. Blaine		Compressive Strength 3 days		Compressive Strength 7 days		Compressive Strength 28 days		Tensile Strength 3 days		Tensile Strength 7 days		Tensile Strength 28 days	
	%	% Var.	%	% Var.	Mins.	Var.	Mins.	Var.	Cm^2/gm	% Var.	Cm^2/gm	% Var.	psi	% Var.	psi	% Var.	psi	% Var.	psi	% Var.	psi	% Var.	psi	% Var.
											Sample No. 28321													
1	21.8	-0.9	0.03	+82.9	175	- 7.9	325	+ 8.3	1729	+1.2	3277	-2.0	932	-1.2	1425	- 9.1	2922	- 2.4	234	+ 5.4	345	+13.5	487	+16.8
2			0.009	-45.1	175	- 7.9	272	- 9.3	1736	+1.6	3353	+0.3	963	+2.1	1637	+ 4.5	3209	+ 7.1	239	+ 7.7	327	+ 7.6	405	- 2.9
3			0.011	-32.9	212	+11.6	348	+16.0	1710	+0.1									197	-11.3	274	- 9.9		
4	22.4	+1.8	0.01	-39.0	185	- 2.6	265	-11.7					907	-3.8	1603	- 2.3	3225	+ 7.7	212	- 4.5	278	- 8.6	372	-10.8
5					175	- 7.9	290	- 3.3					1255*		1930	+23.2			186	-16.2	267	-12.2		
9			0.11*		228	+20.0	360	+20.0	1708	0.0									266	+19.8	368	+21.1		
10	21.8	-0.9	0.03	+82.9	193	+ 1.6	253	-15.7	1682	-1.5	3399	+1.7			1146	-26.9	2622	-12.5			268	-11.8	412	- 1.2
11			0.016	- 2.4	220	+15.8	330	+10.0	1629*				970	+2.9	1660	+ 5.9			220	- 0.9	320	+ 5.3		
12			0.009	-45.1	150	-21.1	260	-13.3	1681	-1.6											287	- 5.6	408	- 2.2
Average	22.0	1.2	0.0164	47.2	190	10.7	300	12.0	1708	1.0	3343	1.3	943	2.5	1567	12.0	2995	7.4	222	9.4	304	10.6	417	6.8
Maximum	22.4	1.8	0.030	82.9	228	21.1	348	20.0	1736	1.6	3399	2.0	970	3.8	1146	26.9	3225	12.5	266	19.8	368	21.1	487	16.8
Minimum	21.8	0.9	0.009	2.4	150	1.6	253	3.3	1681	0.0	3277	0.3	907	1.2	1930	2.3	2622	2.4	186	0.9	267	5.3	372	1.2
											Sample No. 28322													
1	23.7	0.0	0.08	+16.3	223	+ 2.3	363	+8.0	1821	+1.2	3343	-1.1	1019	- 7.1	1571	- 8.7	3371	- 3.4	264	+10.0	337	+ 3.7	511	+10.0
2			0.068	- 1.2	242	+11.0	312	-7.1	1885	+4.8	3369	-0.4	1038	- 5.4	1740	+ 1.2	3178	- 8.9	266	+10.8	335	+ 3.1	448	- 3.7
3			0.057	-17.2	214	- 1.8	355	+5.7	1850	+2.8									204	-15.0	289	-11.1		
4	24.2	+2.1	0.06	-12.8	215	- 1.4	320	-4.8					1124	+ 2.5	1818	+ 5.7	4034	+15.6	223	- 7.1	308	- 5.2	455	- 2.2
5					190	-12.8	315	-6.2					1314	+19.8	1944	+13.0			184	+23.3	281	-13.5		
9			0.068	- 1.2	222	+ 1.8	355	+5.7	1828	+1.6									277	+15.4	366	+12.6		
10	23.3	-1.7	0.08	+16.3	187	-14.2	325	-3.3	1711	-4.9	3430	+1.4			1484	-13.7	3376	- 3.3			333	+ 2.5	480	+ 3.2
11			0.070	+ 1.7	255	+17.0	360	+7.1	1712	-4.8			990	- 9.8	1765	+ 2.6			260	8.3	365	+12.3		
12			0.067	- 2.1	215	- 1.4	315	-6.2	1786	-0.7											307	- 5.5	430	- 7.5
Average	23.7	1.3	0.0688	8.7	218	7.1	336	6.0	1799	3.0	3381	1.0	1097	8.9	1720	7.5	3490	7.8	240	12.8	325	7.7	465	5.3
Maximum	24.2	2.1	0.08	17.2	255	17.0	363	8.0	1885	4.9	3430	1.4	1314	19.8	1944	13.7	4034	15.6	277	23.3	365	13.5	511	10.0
Minimum	23.3	0.0	0.057	1.2	187	1.4	312	3.3	1711	0.7	3343	0.4	990	2.5	1484	1.2	3178	8.9	184	7.1	281	2.5	430	2.2
											Sample No. 28323													
1	24.9	+2.0	0.08	- 3.5	208	+16.2	315	+ 8.6	1831	+1.4	3323	-1.0	1680	- 6.5	2681	- 6.7	4304	+ 2.3	338	+ 5.3	433	+3.6	535	+11.9
2			0.077	- 7.1	158	-11.7	220	-24.1	2051*		3358	0.0	1853	+ 3.2	3033	+ 5.5	4201	- 0.2	339	+ 5.6	397	-5.0	431	- 9.8
3			0.060	-27.6	160	-10.6	255	-12.1	1875	+3.6									312	- 2.8	390	-6.7		
4	24.4	0.0	0.08	- 3.5	165	- 7.8	265	- 8.6					2159	+20.2	2933	+ 2.0	4742	+12.7	280	-12.8	418	0.0	462	- 3.3
5					193	+ 7.8	360	+24.1					1483	-17.4	3054	+ 6.2			273	-15.0	349*			
9			0.082	- 1.1	210	+17.3	335	+15.5	1863	+2.9									345	+ 7.5	401	-4.1		
10	23.8	-2.5	0.10	+20.6	172	- 3.9	247	-14.8	1786	-1.3	3391	+1.0			2455	-14.6	3584	-14.8			422	+1.0	499	+ 4.4
11			0.086	+ 3.7	175	- 2.2	315	+ 8.6	1752	-3.2			1805	- 0.5	3095	+ 7.7			360	+12.1	445	+6.5		
12			0.098	+18.2	170	- 5.0	300	+ 3.4	1747	-3.5											437	+4.5	463	- 3.1
Average	24.4	1.5	0.0829	10	179	9.2	290	13.3	1810	2.7	3357	0.7	1796	9.6	2875	7.1	4208	7.5	321	8.7	418	3.9	478	6.5
Maximum	24.9	2.5	0.100	27.6	210	17.3	360	24.1	1875	3.6	3323	1.0	2159	20.2	3095	14.6	4742	14.8	360	15.0	445	6.7	535	11.9
Minimum	23.8	0.0	0.060	1.1	158	2.2	220	3.4	1747	1.3	3391	0.0	1483	0.5	2455	2.0	3584	0.2	273	2.8	390	0.0	431	3.1

*Not used in computing averages

Table F (cont'd)

Laboratory	Normal Consistency		Soundness Autoclave		Time of Set Initial		Time of Set Final		Fineness-Spec. Surf. Wagner		Fineness-Spec. Surf. Blaine		Compressive Strength 3 days		Compressive Strength 7 days		Compressive Strength 28 days		Tensile Strength 3 days		Tensile Strength 7 days		Tensile Strength 28 days	
	%	% Var.	%	% Var.	Mins.	Var.	Mins.	Var.	Cm^2/gm	% Var.	Cm^2/gm	% Var.	psi	% Var.	psi	% Var.	psi	% Var.	psi	% Var.	psi	% Var.	psi	% Var.
												Sample No. 28324												
1	23.8	-0.8	0.21	- 7.5	148	-14.7	350	+ 5.1	1720	+1.5	3150	-0.8	1673	- 2.7	2636	-11.3	4432	- 3.1	337	+2.1	460*		556	+13.2
2			0.218	- 3.9	215	+23.9	300	- 9.9	1785	+5.3	3167	-0.2	1768	+ 2.9	3177	+ 6.9	4684	+ 2.4	335	+1.5	417	+4.0	488	- 0.6
3			0.223	- 1.8	133	-23.3	313	- 6.0	1770	+4.4									315	-4.5	395	-1.5		
4	24.2	+0.8	0.19	-16.3	180	+ 3.7	280	-15.9					1962	+14.1	3284	+10.5	5471	+19.6	326	-1.2	403	+0.5	470	- 4.3
5					155	-10.7	305	- 8.4					1536	-10.6	2888	- 2.9			241*		387	-3.5		
9			0.0119*		273*	*	392	+17.7	1715	+1.2									343	+3.9	417	+4.0		
10	24.0	0.0	0.26	+14.5	157	- 9.5	290	-12.9	1608	-5.1	3205	+1.0			1694*		3704	-19.0			394	-1.7	500	+ 1.8
11			0.236	+ 3.9	220	+26.8	360	+ 8.1	1694	-0.1			1655	- 3.7	2880	- 3.1			325	-1.5	440*			
12			0.254	+11.9	180	+ 3.7	405	+21.6	1573	-7.2											393	-2.0	443	- 9.8
Average	24.0	0.5	0.227	8.5	173.5	14.5	333	11.7	1695	3.5	3174	0.7	1719	6.8	2973	6.9	4573	11.0	330	2.5	401	2.5	491	5.9
Maximum	24.2	0.8	0.26	16.3	220	26.8	405	21.6	1785	7.2	3205	1.0	1962	14.1	3284	11.3	5471	19.6	343	4.5	417	4.0	556	13.2
Minimum	23.8	0.0	0.19	1.8	133	3.7	280	5.1	1573	0.1	3150	0.2	1536	2.7	2636	2.9	3704	2.4	315	1.2	387	0.5	443	0.6
												Sample No. 28325												
1	25.2	+2.0	0.24	-18.4	215	- 3.6	390	+ 5.4	1805	-0.7	3303	+0.1	1321	-16.6	1951	-21.7	3443	- 5.9	302	- 2.6	417	+7.2	530	+7.9
2			0.305	+ 3.7	225	+ 0.9	342	- 7.6	1923	+5.8	3170	-3.9	1602	+ 1.1	2673	+ 7.3	4082	+11.6	310	- 0.0	380	-2.3	468	-4.7
3			0.231	-21.4	193	-13.5	340	- 8.1	1885	+3.7									275	-11.3	355	-8.7		
4	24.4	-1.2	0.26	-11.6	190	-14.8	325	-12.2					1558	- 1.6	2683	+ 7.7	4250	+16.2	307	+ 1.0	377	-3.1	482	-1.8
5					130	-41.7	295	-20.3					1925	+21.5	3183	+27.8			233*		321*			
9			0.331	+12.6	270	+21.1	392	+ 5.9	1820	+0.2									338	+ 9.0	407	+4.6		
10	24.5	-0.8	0.36	+22.4	188	-15.7	370	0.0	1847	+1.7	3425	+3.8			1846	-25.9	2860	-21.8			379	-2.6	503	+2.4
11			0.301	+ 2.4	265	+18.8	410	+10.8	1718	-5.4			1515	- 4.4	2610	+ 4.8			325	4.8	420	+8.0		
12			0.326	+10.9	330	+48.0	465	+25.7	1723	-5.2											375	-3.6	470	-4.3
Average	24.7	1.3	0.294	12.9	223	19.8	370	10.7	1817	3.2	3299	1.6	1584	9.0	2491	15.9	3659	13.9	310	4.8	389	5.0	491	4.2
Maximum	25.2	2.0	0.36	22.4	330	48.0	465	25.7	1923	5.8	3425	3.9	1925	21.5	3183	27.8	4250	21.8	338	11.3	420	8.7	530	7.9
Minimum	24.4	0.8	0.231	2.4	130	0.9	295	0.0	1718	0.2	3170	0.1	1321	1.1	1846	4.8	2860	5.9	275	0.0	355	2.3	468	1.8
												Sample No. 28326												
1	21.9	-1.8	0.0	+100.0	120	-24.5	285	- 0.3	1884	+0.6	3170	-2.2	1320	- 4.3	1938	- 2.0	3216	- 1.3	270	+ 1.9	383	+2.7	519	+8.6
2			-0.019	-111.1	155	- 2.5	235	-17.8	1912	+2.1	3373	+4.1	1362	- 1.3	2117	+ 7.0	3393	+ 4.1	278	+ 4.9	370	-0.8	457	-4.4
3			0.006	+166.7	113	-28.9	258	- 9.8	1940	+3.6									270	+ 1.9	351	-5.9		
4	22.8	+ 2.2	-0.01	+ 11.1	170	+ 6.9	255	-10.8					1540	+11.6	2233	+12.9	3771	+15.7	232	-12.5	358	-4.0	468	-2.1
5					75	-52.8	190	-33.6					2097*		3127*				208	-21.5	298*			
9			-0.014	- 55.6	225	+41.5	365	+27.6	1895	+1.2									299	+12.8	403	+8.0		
10	22.2	- 0.4	0.08*		192	+20.8	385	+34.6	1838	-1.9	3178	-1.9			1631	-17.5	2658	-18.5			384	+2.9	506	+5.9
11			-0.024	-166.7	180	+13.2	305	+ 6.6	1809	-3.4			1300	- 5.8	1970	- 0.4			295	+11.3	380	+1.9		
12			-0.003	+ 66.7	200	+25.8	300	+ 4.9	1833	-2.1											353	-5.4	440	-7.9
Average	22.3	1.5	-0.009	96.8	159	24.1	286	16.2	1873	2.1	3240	2.7	1380	5.8	1978	8.0	3260	9.9	265	9.5	373	4.0	478	5.8
Maximum	22.8	2.2	+0.006	166.7	225	52.8	385	34.6	1940	3.6	3170	4.1	1540	11.6	2233	17.5	3771	18.5	299	21.5	403	8.0	519	8.6
Minimum	21.9	0.4	-0.024	11.1	75	2.5	190	0.3	1809	0.6	3373	1.9	1300	1.3	1631	0.4	2658	1.3	208	1.9	351	0.8	440	2.1
												Sample No. 28327												
1	23.0	- 0.4	0.14	+12.9	120	- 6.2	285	+19.2	1658	0.0	3243	+0.6	1185	-19.5	2035	-12.4	3406	+ 1.1	306	-1.9	413	+8.4	487	+12.7
2			0.110	-11.3	102	-20.3	172	-28.0	1715	+3.4	3212	-0.3	1470	- 0.1	2442	+ 5.1	3467	+ 2.9	297	-4.8	361	-5.2	429	- 0.7
3			0.117	- 5.6	108	-15.6	200	-16.3	1770	+6.8									302	-3.2	369	-3.1		
4	22.8	- 1.3	0.13	+ 4.8	110	-14.1	205	-14.2					1474	+ 0.1	2508	+ 7.9	3625	+ 7.6	310	+0.6	383	+0.5	402	- 6.9
5					140	+ 9.4	273	+14.2					1961	+33.2	2889	+24.3			313	+0.3	357	-6.3		
9			0.123	- 0.8	170	+32.8	298	+24.7	1642	-1.0									329	+5.4	386	+1.3		
10	23.5	+ 1.7	0.11	-11.3	148	+15.6	245	+ 2.5	1564	-5.7	3215	-0.2			1913	-17.7	2973	-11.7			389	+2.1	437	+ 1.2
11			0.126	+ 1.6	150	+17.2	270	+13.0	1642	-1.0			1270	-13.7	2160	- 7.1			325	4.2	400	+5.0		
12			0.136	+ 9.7	100	-21.9	200	-16.3	1617	-2.5											373	-2.1	403	- 6.7
Average	23.1	1.1	0.124	7.3	128	17.0	239	16.5	1658	2.9	3223	0.4	1472	13.3	2324	12.4	3368	5.8	312	2.9	381	3.8	432	5.6
Maximum	22.8	1.7	0.14	12.9	170	32.8	298	28.0	1770	6.8	3243	0.6	1961	33.2	2889	24.3	3625	11.7	329	5.4	413	8.4	487	12.7
Minimum	23.5	0.4	0.110	0.8	100	6.2	172	2.5	1564	0.0	3212	0.2	1185	0.1	1913	5.1	2973	1.1	297	0.3	357	0.5	402	0.7

*Not included in computing averages

CHART XVI
SOUNDNESS BY AUTOCLAVE

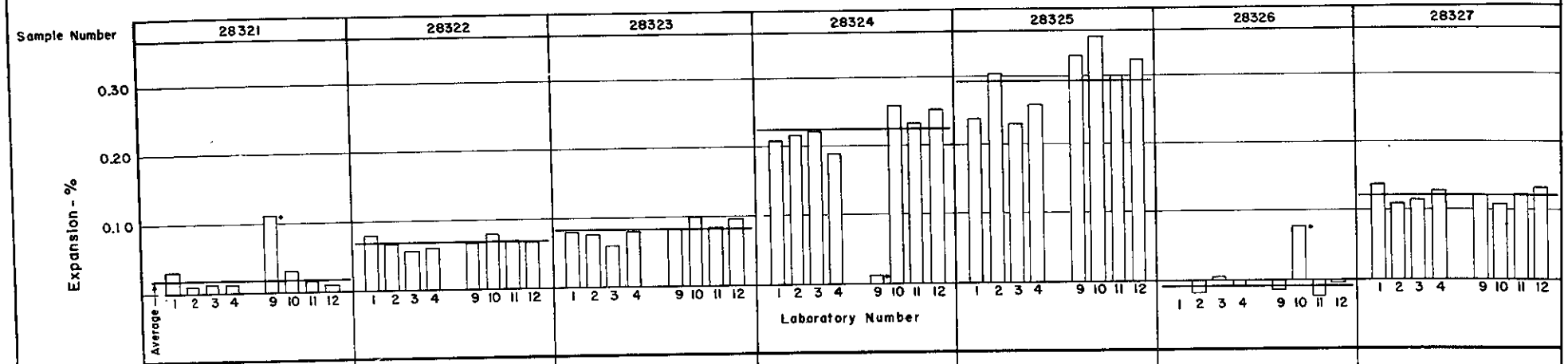


CHART XVII
SETTING TIME OF PORTLAND CEMENT